

# The Role of Language Arts in a Successful STEM Education Program

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# Introduction and Agenda

- Welcome and Introduction
- Our goals for today
  - ELA –a look at literacy
  - ELA –the science connection
  - The culture of science-discourse and practices
  - Academic language

*During the last twenty years our nation's educational system has scored some extraordinary successes, especially in improving the reading and writing skills of young children. Yet the pace of literacy improvement has not kept up with the pace of growth in the global economy, and literacy gains have not been extended to adolescents in the secondary grades.*

Time to Act: An Agenda for Advancing Adolescent Literacy for College and Career Success.

Final Report of the Carnegie Corporation of New York's Council on Advancing Adolescent Literacy, 2010

# What happens from 4<sup>th</sup> grade to 12th grade?

- Literacy demands change
  - Vocabulary demand increases
  - Texts become longer
  - Sentence complexity increases
  - Structural complexity increases
  - Graphical representation becomes more important
  - Conceptual Challenge increases
  - Types of texts used vary widely across content areas

The major difference between reading in grades K-5 and reading in grades 6-12 is the transition from *learning to read* to *reading to learn*.

*Reading in the Disciplines: The Challenges of Adolescent Literacy*  
Carnegie Corporation, 2010

*High school graduates today are increasingly expected to judge the credibility of sources, evaluate arguments, and understand and convey complex information in the college classroom, in the workplace...*

*The ability to reason allows for the systematic development of ideas, the ability to make sound choices, and the ability to make and understand persuasive arguments.*

American Diploma Project, 2004, p. 29

Among the strengths that distinguish the Common Core Standards are...the focus on reading and writing across the curriculum, which are skills that colleges and employers value...

*Memo from Dr. Mitchell D. Chester, Commissioner of the Board of Elementary and Secondary Education of Massachusetts to Board members, July 16, 2010*

- The idea that instruction in English language arts should be integrated into science instruction and that science texts should be integrated into English language arts instruction is being considered today by more and more educators and policy makers.

- This is most evident in the Common Core State Standards in English Language Arts (CCSSO, NGA)
- The full title of the standards document is: *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects.*

# Why is an interdisciplinary approach to literacy development important?

- *There is a need for college and career ready students to be proficient in reading complex informational text independently in a variety of content areas because most of the required reading in college and workforce training programs is informational in structure and challenging in content*
- *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects, p.4*

The ELA CCSS cites the 2009 NAEP reading framework as also calling for a special emphasis on informational text.

- Informational reading (as opposed to literary reading) should increase throughout the grades from 50% in 4<sup>th</sup> grade to 70% in 12<sup>th</sup> grade.
- The overwhelming focus of writing throughout high school should be on arguments and informative/explanatory texts (p. 5)

# A shared responsibility

- The CCSS recognize that ELA teachers cannot accomplish this alone and that all ELA experiences cannot focus on informational text. Therefore, as part of a school wide literacy program, much of the responsibility for teaching students how to engage with informational text should rest with teachers of social studies, history, science, and technical subjects, as well as teachers of other subjects in the school.

# Examples of CCSS relevant to Science

Anchor Standards 8 for reading says:

- *Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence (p. 10).*

Anchor standards for writing include:

- *Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.*
- *Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.*
- *Draw evidence from literacy or informational texts to support analysis, reflection, and research.*

Anchor standards for speaking and listening include:

- *Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.*
- *Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience (p. 48).*

- *Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations (p. 48).*

These anchor standards are elaborated for each grade from K-8 and then for grade bands 9-10 and 11-12.

ELA standards are consistent with existing national standards in science

- *Interpret written descriptions of real-world objects and events.*
- *Write a clear and accurate description of a real-world object or event.*
- *Locate information in reference books, back issues of newspapers and magazines, compact disks, and computer databases.*

- *Benchmarks for Science Literacy* of Project 2061 of the American Association for the Advancement of Science (1993)

- *Present a brief scientific explanation orally or in writing that includes a claim and the evidence and reasoning that supports the claim.*
- *Seek to gain a better understanding of a scientific idea by asking for an explanation, restating an explanation in a different way, and asking questions when some aspect of an explanation is not clear.*
- *Explain a scientific idea to someone else, checking understanding and responding to questions.*

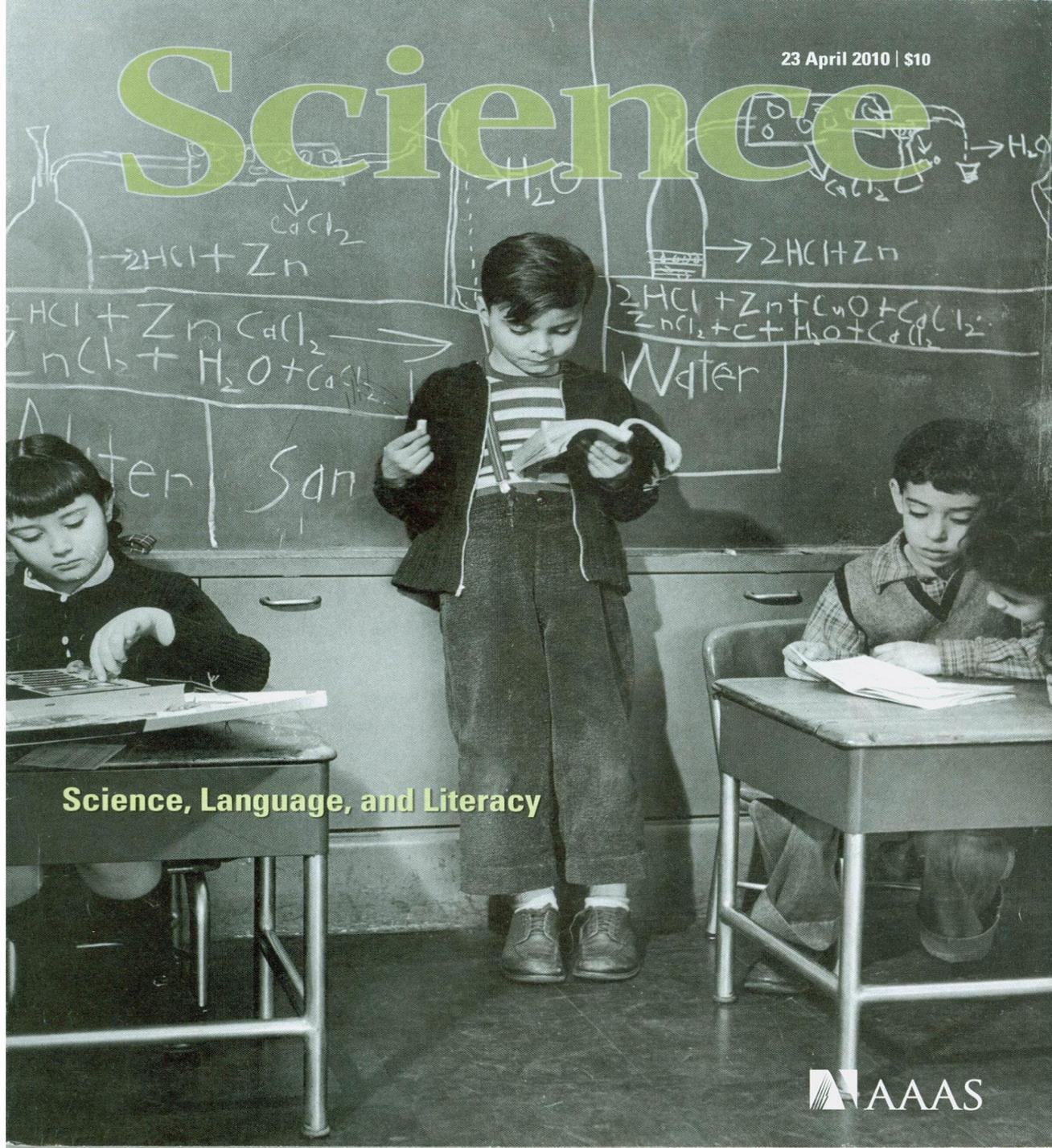
Chapter 12 of Benchmarks, Habits of Mind; Communication Skills; Critical Response Skills

- *Notice and criticize the reasoning in arguments in which fact and opinion are intermingled.*
- *Notice and criticize the reasoning in arguments in which the claims are not consistent with the evidence given.*
- *Be skeptical of claims based only on analogies.*

Clearly there is an overlap between ELA Common Core Standards and existing standards in science.

If done well, the integration of ELA with science could be an effective approach to teaching science content, reasoning and critical response skills, and literacy skills.

# Science



**Science, Language, and Literacy**

As the editors of the special section put it:

- *Science is about generating and interpreting data, but it is also about communicating facts, ideas, and hypotheses. Scientists write, speak, debate, visualize, listen, and read about their specialties daily. For students unfamiliar with the language or style of science, the deceptively simple act of communication can be a barrier to understanding or becoming involved with science (p. 447).*

# Issues to overcome.

- Could emphasis on the reading of science texts replace hands-on, inquiry-based science?
  - “...when science literacy is conceptualized as a form of inquiry, reading and writing activities can be used to advance scientific inquiry, rather than substitute for it. When literacy activities are driven by inquiry, students simultaneously learn how to read and write science texts and to do science”

Pearson, Moje, and Greenleaf: *Science*, 2010, pp. 459-460

# The Culture of Science

- Discourse
  - Claims and evidence
- Science Practices
  - Modeling

# Discourse

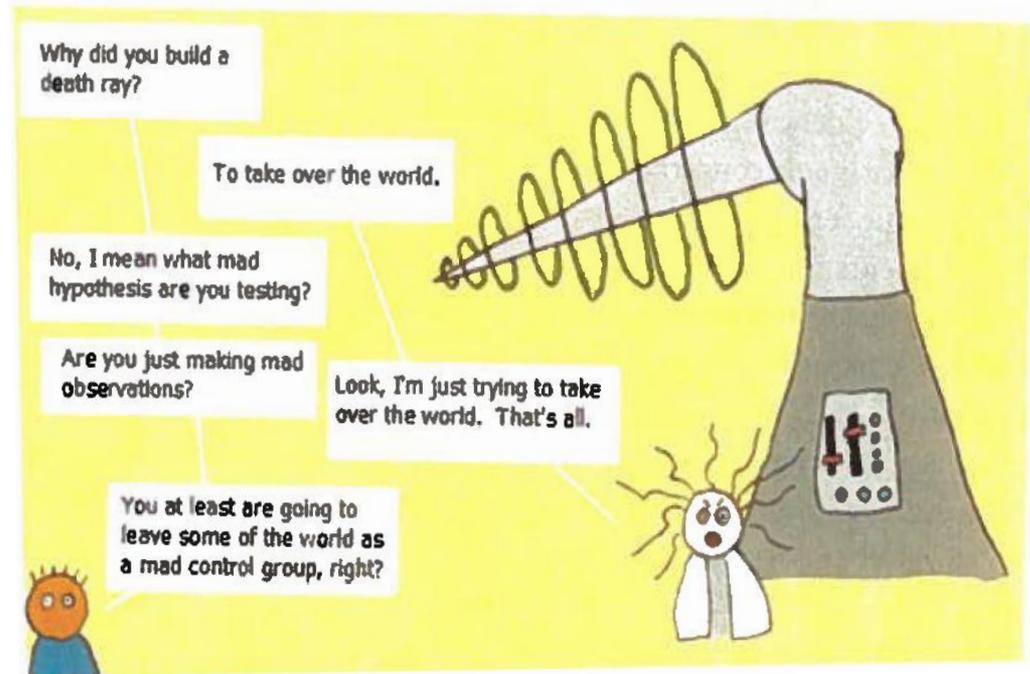
- Science is a communal activity
- Scientist must share explanations & predictions with other scientist
  - Published results of scientific investigations
  - Oral presentations & meetings
  - Grant writing
  - The peer review process

# Discourse

Teachers and students should be expected to use in their classroom discourse the language, representations and reasoning structures that are accepted by scientists.

## Death ray (Kulkarni 2009).

Popular media's portrayal of scientists and engineers at work can unintentionally reinforce misconceptions of both the science and engineering models of experimentation.



# Discourse

Science discourse goes beyond proper language

- It engages students in making clear, to themselves and others, not just what they know, but how they know it. Claims are made; evidence is produced; and explanations are formulated, revised and extended through science discourse during which claims, evidence and reasoning are discussed and critiqued.

# STANDARDS OUTLINE: SCIENCE PRACTICES

## STANDARD SP.1

- Asking scientific questions that can be tested empirically and structuring these questions in the form of testable predictions

### OBJECTIVES:

- SP.1.1 Scientific Questions
  - SP.1.2 Predictions

## STANDARD SP.2

- Collecting data to address scientific questions and to support predictions

### OBJECTIVES:

- SP.2.1 Data Collection
- SP.2.2 Evaluating Data for Evidence

## STANDARD SP.3

- Searching for regularities and patterns in observations and measurements (i.e., data analysis)

### OBJECTIVE:

- SP.3.1 Analyzing Data for Patterns

## STANDARD SP.4

- Using evidence and scientific explanations to describe natural phenomena

### SP.4.2 Models and Representations

- SP.4.1 Constructing Explanations
- SP.4.2 Models and Representations
- SP.4.3 Evaluating Explanations

## SP.5

- Using mathematical reasoning and representations to describe natural phenomena

Students construct, use, re-express and revise models and representations of natural and designed objects, systems, phenomena and scientific ideas in the appropriate context and in formulating their explanation.

# Science Practices - Modeling

- Modeling is both a form of communication and a tool for making predictions.
- Models may help others understand the conclusions of a scientist, but they are also a public display of a scientist's understanding of the world, as well as a way for all to test predictions about the world (i.e., what is expected to happen under the conditions described in the model).

# Next Generation Science Standards

- Three dimensions of the framework –
- Developing understanding of disciplinary ideas,
- Cross-cutting elements
- Science practices
- “Presented separately, but must be woven together in standards, curriculum, instruction and assessment, so that students gain an understanding of science as a discipline (or as a way of knowing) that supports their development of coherent and integrated knowledge about science, of the practices for applying and expanding that knowledge” (NRC, 2010).

# All students are multi-lingual

## They speak:

The language of the home

The language of the street

The language of the classroom

(Academic Language)

# An Example...

What is *work*?

Home: Do your work

Street: He is going to work

Classroom:  $Work = force \times distance$

Children who read well are not necessarily good readers.

Children who read words fluently and accurately often have trouble comprehending text.

Some Examples:  
From Science  
From Mathematics

**FIGURE No. 4.** | *Elementary, middle, and high school level texts excerpts about seeds.*

Elementary school level	Middle school level	High school level
<p><i>Science</i> (Harcourt Brace, 2005)</p> <p><b>Plants and Seeds</b></p> <p><b>Plants Without Seeds</b> You have read that some simple plants don't have roots, stems, or leaves. These simple plants don't have seeds either. They reproduce by spores.</p> <p>The seed is the first stage of growth in many plants that have roots, stems, and leaves. However, not all of these plants produce seeds. Ferns are examples of this type of plant. Ferns, like simpler plants, reproduce by spores. These spores are found on the bottom of the fern leaves, or fronds.</p>	<p><i>Science Explorer: Discoveries in Life, Earth and Physical Science</i> (Prentice Hall, 2004).</p> <p><b>Characteristics of Seedless Vascular Plants</b></p> <p>The odd-looking plants in the ancient forests were the ancestors of three groups of plants, that are alive today—ferns, club mosses, and horsetails. Ferns and their relatives share two characteristics. They have vascular tissue and use spores to reproduce.</p> <p><b>Vascular Tissue</b> What adaptations allowed plants to grow very tall? Unlike the mosses, the ancient trees were vascular plants—plants that have vascular tissue. Vascular plants are better suited to life on land than are nonvascular plants. This is because vascular tissue solves the problems of support and transportation. Vascular tissue transports water quickly and efficiently through the plant's body. It also transports the food produced in the leaves to other parts of the plant, including the roots.</p> <p>In addition, vascular tissue strengthens the plant's body. Imagine a handful of drinking straws bundled together with rubber bands. The bundle of straws would be stronger and more stable than a single straw would be. In a similar way, vascular tissue provides strength and stability to a plant.</p> <p>Spores for Reproduction Ferns, club mosses, and horsetails still need to grow in moist surroundings. This is because the plants release spores into their surroundings, where they grow into gametophytes. When gametophytes produce egg cells and sperm cell, there must be enough water available for fertilization to occur.</p>	<p><i>Biology: The Dynamics of Life</i> (Glencoe, 2004)</p> <p><b>Non-seed Plants</b></p> <p>The divisions of non-seed plants are shown in Figure 21.6. These plants produce hard-walled reproductive cells called spores. Non-seed plants include vascular and nonvascular organisms.</p> <p><b>Hepatocophyta</b> Hepatocophytes (hey PAH tih koh fites) include small plants commonly called liverworts. Their flattened bodies resemble the lobes of an animal's liver. Liverworts are nonvascular plants that grow only in moist environment. Water and nutrients move throughout a liverwort by osmosis and diffusion. Studies comparing the biochemistry of different plant divisions suggest that liverworts may be the ancestors of all plants.</p> <p>There are two kinds of liverworts: thallose liverworts and leafy liverworts. Thallose liverworts have a broad body that looks like a lobed leaf. Leafy liverworts are creeping plants with three rows of thin leaves attached to a stem.</p> <p><b>Anthocrophyta</b> Anthocrophytes (an THOH ser oh fites) are also small thallose plants. The sporophytes of these plants, which resemble the horns of an animal, give the plants their common name—hornworts. These nonvascular plants grow in damp, shady habitats and rely on osmosis and diffusion to transport nutrients.</p> <p><b>Bryophyta</b> Bryophytes (BRI uh fites), the mosses, are nonvascular plants that rely on osmosis and diffusion to transport materials. However, some mosses have elongated cells that conduct water and sugars. Moss plants are usually less than 5 cm tall and have leaf like structures that are usually only one to two cells thick. Their spores are formed in capsules.</p> <p><b>Psilophyta</b> Psilophytes, known as whisk ferns, consist of thin, green stems. The psilophytes are unique vascular plants because they have neither roots nor leaves. Small scales that are flat, rigid, overlapping structures cover each stem. The two known genera of psilophytes are tropical or subtropical. Only one genus is found in the southern United States.</p>
<p>Review question: What is a seed?</p>	<p>Review question: What adaptation allowed plants to grow tall?</p>	<p>Review question: Describe the main difference between bryophytes and psilophytes.</p>

This question requires you to show your work and explain your reasoning. You may use drawings, words, and numbers in your explanation. Your answer should be clear enough so that another person could read it and understand your thinking. It is important that you show all your work.

Describe a procedure for locating the point that is the center of a circular paper disk. Use geometric definitions, properties, or principles to explain why your procedure is correct. Use the disk provided to help you formulate your procedure. You may write on it or fold it in any way that you find helpful, but it will not be collected.

NAEP, 2005; Grade 12

Results: 22.78%  
correct

In a certain restaurant a whole pie has been sliced into 8 equal wedges. Only 2 slices of the pie remain. Three people would each like an equal portion from the remaining slices of pie. What fraction of the original pie should each person receive?

Answer: \_\_\_\_\_

NAEP, 2005; Grade 12

22.22% correct

# How do we know they understand?

- What have they learned?
- Can they answer questions in a logical manner?
- Does the answer “make sense”?
- Can they transfer what they have just learned to a concept that is built upon this?

What do we have to do to insure understanding?

# Policy Issues

The ELA Common Core Framework recommends increasing the amount of time that students spend studying informational texts. Due to the obvious time constraints, they propose that non-ELA teachers do some of this teaching as well. Assuming there are benefits to students in having ELA integrated into the science program as recommended in the Common Core Standards, what would it take to get non-ELA teachers to do it?

- Would additional time be needed for science teaching if science teachers were expected to explicitly teach the skills identified in the Common Core ELA Standards or would the time come from taking away something that science teachers now do?
- Would science teachers be willing to teach ELA skills? Spend class time on this?
- Would PD be needed or would science teachers be naturally good at this?

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